PB-227 647

SEEPAGE INVESTIGATION BRINE STORAGE TANKS VILLAGE OIL FIELD COLUMBIA COUNTY, ARKANSAS

Public Health Service
Dallas, Texas

May 1956

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

U.S. P-N-S-

043082

SEEPAGE INVESTIGATION
BRINE STORAGE TANKS
VILLAGE OIL FIELD
COLUMBIA COUNTY, ARK.

U. S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE

MASON - JOHNSTON & ASSOCIATES
GEOLOGISTS - ENGINEERS
DALLAS, TEXAS

R

GEOLOGISTS

PB 227 647

SEEPAGE INVESTIGATION
BRINE STORAGE TANKS
VILLAGE OIL FIELD
COLUMBIA COUNTY, ARKANSAS

U. S. Department of Health, Education & Welfare
U. S. Public Health Service
Dallas, Texas

May, 1956

Reproduced from best available copy.

Mason-Johnston & Associates
Geologists-Engineers
Dallas, Texas

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

ENGINEERS

SEEPAGE INVESTIGATION

BRINE STORAGE TANKS

VILLAGE OIL FIELD

COLUMBIA COUNTY, ARKANSAS

TABLE OF CONTENTS

GENERAL - page 1
FIELD EXPLORATION AND SAMPLING - - - - - - - - - - page 1
LABORATORY TESTS - - - - - - - - - - - - - - - - - page 3
SEEPAGE ANALYSIS - RESISTIVITY DATA - - - - - - - page 4
SEEPAGE ANALYSIS - PERMEABILITY DATA - - - - - - - page 6
CONCLUSIONS - page 7

SEEPAGE INVESTIGATION

BRINE STORAGE TANKS

VILLAGE OIL FIELD

COLUMBIA COUNTY, ARKANSAS

GENERAL:

In accordance with agreements dated 14 February and 20 February 1956, a field exploration and sampling program and a laboratory investigation have been made at the sites of selected Brine Storage Reservoirs, Village Oil Field, in Columbia County, Arkansas. An analysis of seepage loss through, or under, the retaining dikes or embankments has been made for each site studied.

FIELD EXPLORATION AND SAMPLING:

A reconnaisaance of the area was made by representatives of the U. S. Public Health Service and Mason-Johnston and Associates; from this inspection, three sites were selected for study as being typical of the Village Oil Field.

The attached plate, entitled"Schematic Map", shows the approximate relationship of various features of the Field. The sites selected as typical are shown on the plate and are identified as :

"Machen Number 1 and 3"
"Hunt Harwell Number 1"
"J. J. Gunnels".

Undisturbed samples of soil were obtained from two locations at each site; the first sample was obtained from the dike, above the saturation line, and reflected the in-situ properties of the dike. The second sample was obtained from the natural ground at a distance of 20 to 35 feet downslope from the dike and represented the original foundation soils.

Each sample was taken as a "pedestal" type of undisturbed sample in the following manner: a trench, about one foot deep and one foot wide, was excavated around the soil which was to form the sample; a suitable box was lowered over the soil pedestal and the bottom of the pedestal was cut free; the box was inverted and the space between the soil and box filled with parafin. Following this operation, the sample was identified as to location, depth, date taken, soil type, etc, and the entire box and sample coated with parafin so as to insure no change in moisture or physical properties.

Each sample was packed for shipment and transported to the laboratory by automobile, where it was stored in a constant humidity, air-conditioned room until tested.

An electrical resistance profile was run at each site from the brine storage dike to the nearest natural drainage feature (usually a creek) to furnish an index as to the depth, below existing ground surface, of the seepage flow. The method employed a Geophysical Electrical Resistivity instrument and consisted, in essence, of determining the electrical resistance of the upper six inches of soil. High resistance values are indicative of salt-free dry soil while low resistance values are indicative of moist to wet soils containing dissolved salts.

The graphical results of the resistivity profile are shown on the attached sheets for sites "Macher Number 1 and 3" and "Hunt Harwell Number 1". No profile could be obtained at the site "J. J. Gunnels" due to the presence of free water with a high salt content on the ground surface (unit resistance values less than 1.0 ohm).

LABORATORY TESTS:

The samples from each site were analyzed in the laboratory for permeability values, void ratio and soil index properties. The results of the testing program are tabulated on the attached sheet entitled "Laboratory Results".

All samples have a low plasticity index, are classified as low to non-plastic and, by name, are silty sands. The permeability coefficients place all samples in a medium range on a scale of impervious, medium and pervious.

SEEPAGE ANALYSIS - RESISTIVITY DATA:

The purpose of the Geophysical electrical resistivity profile was to determine the extent of seepage downslope from the storage reservoir. As can be seen from the attached resistivity profiles, Sheets 2 R and 3 R, the unit resistance for soils of"normal" density and moisture content is in the range of 1000 ohm - centimeters.

The effect of higher moisture contents in a given soil condition is to reduce the unit resistance. The same type of reduction occurs when the moisture content is held constant and the dissolved salt content in the soil moisture is increased.

Accordingly, the conclusions from the resistivity profile for "Machen Number 1 and 3" site are:

1) The soils present at the site, when not influenced by dissolved salts or seepage, have unit resistivity values in the range of 1000+ ohm-centimeter. Such an area was found on the top of the dike and on two high areas some 300 and 500 feet downslope from the dike.

2) Zones of influence of dissolved salts or seepage reduced unit resistivity values very much lower than 1000 ohm-centimeters, from the dike to the nearest surface drainage feature which was a creek some 750 feet from the reservoir.

For the "Hunt Harwell Number 1" site, the following conclusions are made:

1) The entire dike, even the top surface, has a unit resistivity value lower than "normal" and the reduction is due to dissolved salts in the soil water and/or seepage.

2) The zone of influence of dissolved salts or seepage extend to the nearest surface drainage feature, a creek, some 150 feet from the reservoir.

For the "J. J. Gunnels" site, no resistivity profile could be obtained due to the presence, on the ground surface, of seepage water flowing from the reservoir to the surface drainage creek nearby. At this site at least three small, active, sand boils were observed immediately downslope from the dike toe. Accordingly, the rather obvious conclusion can be made that seepage from the reservoir is occurring.

SEEPAGE ANALYSIS - PERMEABILITY DATA:

The flow of any fluid through a soil mass is governed by the law of Darcy; this law can be expressed in the mathematical form:

$$Q = K\,i\,A \quad \text{where,}$$

Q = quantity of flow per unit of time

K = coefficient of permeability

A = area of soil mass through which flow takes place

i = hydraulic gradient

$$= \frac{h}{l} = \frac{\text{difference in head}}{\text{length of path}}$$

For all of the sites investigated, it has been assumed that the geometrical shapes of the dikes are identical and that the total seepage quantity is composed of seepage through the dike plus the seepage through the foundation under the dike; thus, $Q_T = Q_D + Q_F$

$$Q_D = \frac{4\,K\,H^2}{9\,L} = \frac{4\,K\,4^2}{9x5} = \frac{4^3\,K}{45}$$

$$Q_F = K\,\frac{h}{L}\,A = \frac{4\,K\,10}{5} = 8K$$

$$Q_T = \frac{4^3\,K}{45} + 8K = K\left(\frac{4^3}{45} + 8\right) = K(9.42)$$

For the "Macher Number 1 and 3" site, K equals 1.81×10^{-4} *cubic feet per minute. Thus, the total seepage is equal to:*

$$Q_T = 3.62 \times 10^{-4}(9.42) \text{ cu.ft./ min.}$$

$$= 34.10 \times 10^{-4} = 0.00341 \text{ cu.ft./min per lineal foot of dike.}$$

For the "J. J. Gunnels" site,

$Q_T = 2.6 \times 10^{-4}(9.42)$

$= 0.00245$ cu.ft./min. per lineal foot of dike

For the "Hunt Harwell Number 1" site,

$Q_T = 4.4 \times 10^{-5}(9.42)$

$= 0.00041$ cu.ft./min. per lineal foot of dike.

The following tabulation shows the seepage, for each foot of dike, for each site.

Site	Seepage (per lineal foot of dike) cu.ft./day	gal./day
Macher Number 1 and 3	4.91	36.7
Hunt Harwell Number 1	0.59	4.4
J. J. Gunnels	3.53	26.4

CONCLUSIONS:

Based on the results of field, laboratory and office studies reported herein, it is concluded that seepage is occurring from the salt water reservoir at each of the three sites selected as being typical of the Village Field and that the quantity of seepage flow from the reservoirs are in the maynitude of four cubic feet (30 gallons) per day per linear foot of reservoir.

Respectfully submitted,

Raymond C. Mason

Raymond C. Mason
Mason-Johnston and Associates

May, 1956

MASON-JOHNSTON & ASSOCIATES

MAGNOLIA, ARKANSAS

Page ____ of ____

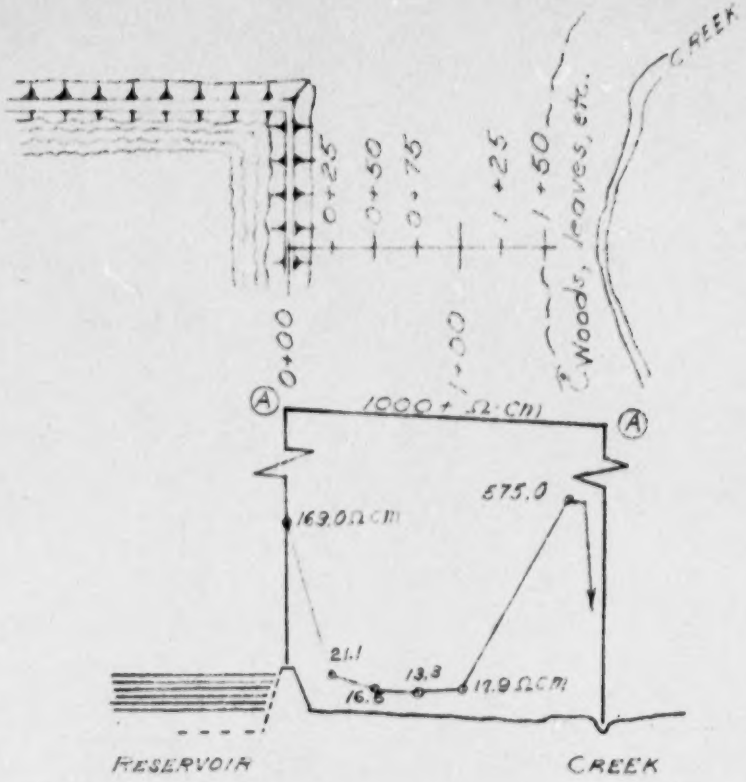
23 March 1956

Date ____

Summary of Test Results

Date ____

Well Location	Sample Location	K_{20}	Void Ration	LL	PI	LS
Macher 1&3	35' D. Stream	1.29×10^{-5}	0.674	-	N.P.	0.0
Macher 1&3	Top of Dam	1.81×10^{-4}	0.722	22.7	5.2	2.0
Hunt Harwell No. 1	35' D.S.	2.2×10^{-5}	0.663	-	N.P.	0.0
Hunt Harwell No. 1	Top of Dam	7.6×10^{-6}	0.583	-	1.9	3.5
J.J. Gunnels	20' D.S.	1.8×10^{-5}	0.676	14.6	-	0.0
J.J. Gunnels	Top of Dam	1.3×10^{-4}	0.87	20.7	1.6	1.9



Notes:

1. Line A-A represents "NORMAL" values for soil not affected by seepage.
2. Values lower than 1000+ Ω cm indicate the relative amounts of moisture and dissolved salts.

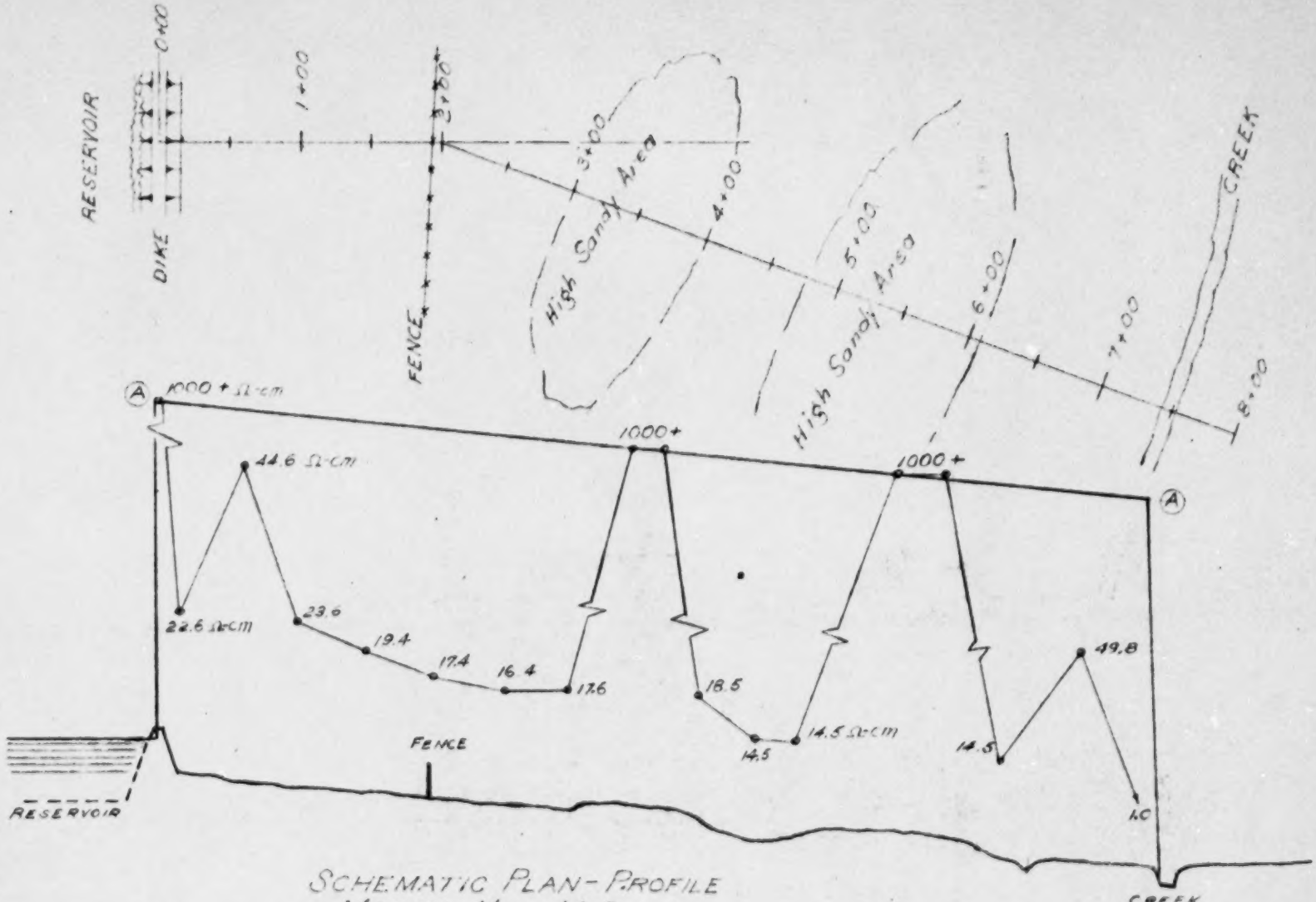
SCHEMATIC PLAN - PROFILE
HUNT HARWELL NO. 1

RESISTIVITY PROFILE

Reproduced from best available copy.

MASON-JOHNSTON & ASSOCIATES
GEOLOGISTS ENGINEERS
DALLAS, TEXAS

SUBJECT U.S.D.A. H.E.W. SHEET NO. 2 R OF
Willcox Field, Ariz.
MADE BY T.D.B. DATE 3/3/56 CHECKED BY DATE
JOB NO. 4405G

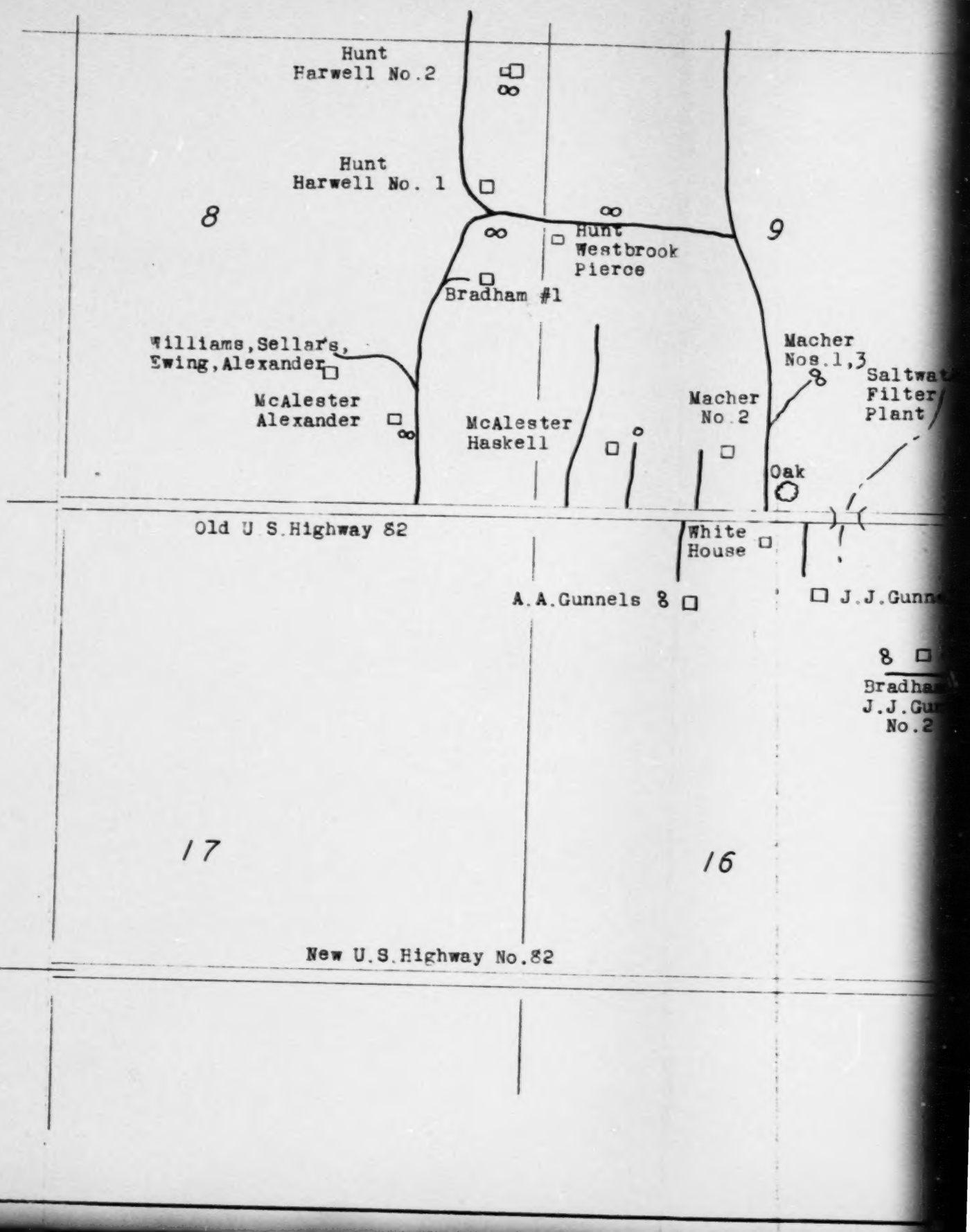


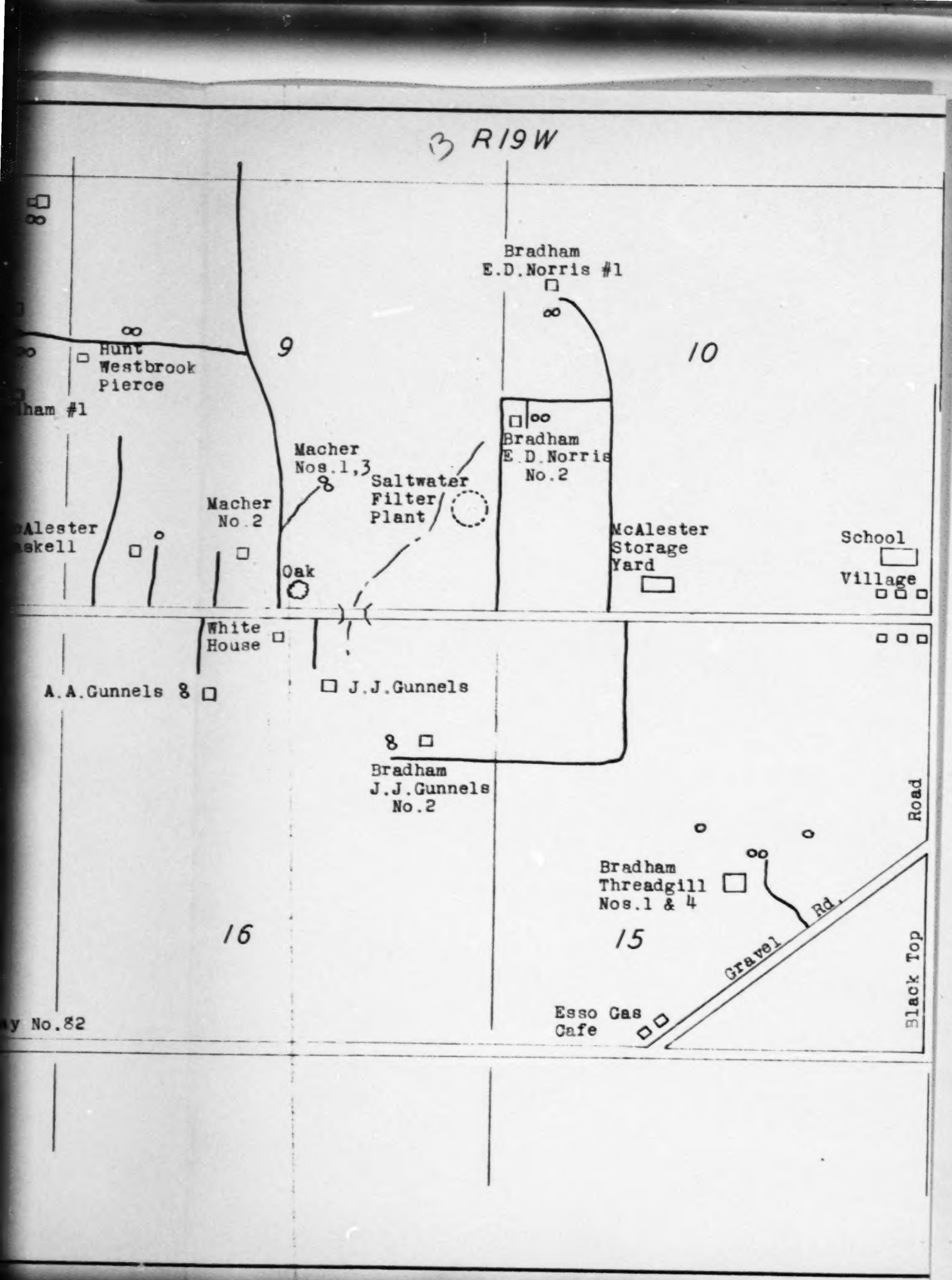
SCHEMATIC PLAN-PROFILE
MACHER Nos. 1 & 3

RESISTIVITY PROFILE

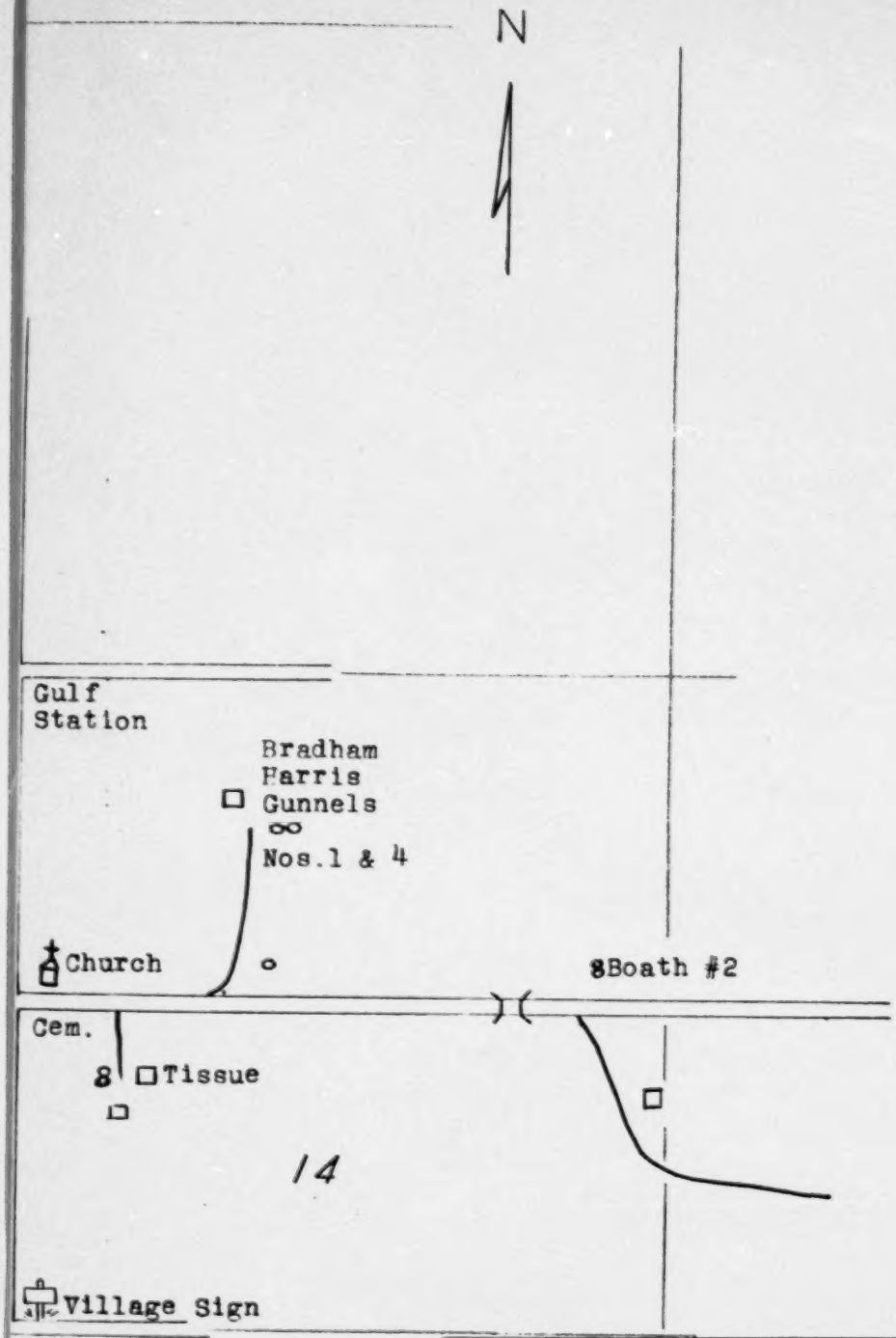
Notes:
1. Line A-A represents "NORMAL" values for soil not affected by seepage
2. Values lower than 1000+ indicate the relative amounts of moisture and dissolved salts.

A


Hunt
Harwell No.2
Hunt
Harwell No. 1
8
9
Hunt
Westbrook
Pierce
Bradham #1
Williams, Sellars,
Ewing, Alexander
McAlester
Alexander
McAlester
Haskell
Macher
Nos.1,3
Macher
No.2
Saltwat
Filter
Plant
Oak
Old U.S.Highway 82
White
House
A.A.Gunnels
J.J.Gunn
8
Bradha
J.J.Gu
No.2
17
16
New U.S.Highway No.82


3 R19W
Bradham
E.D.Norris #1
Hunt
Westbrook
Pierce
9
10
Macher
Nos.1,3
Saltwater
Filter
Plant
Bradham
E.D.Norris
No.2
Macher
No.2
McAlester
Storage
Yard
School
Village
Oak
White
House
A.A.Gunnels
J.J.Gunnels
Bradham
J.J.Gunnels
No.2
Bradham
Threadgill
Nos.1 & 4
16
15
Gravel
Rd.
Road
Black Top
Esso Gas
Cafe

C



MASON-JOHNSTON & ASSOCIATES
GEOLOGISTS - ENGINEERS
DALLAS, TEXAS

SCHEMATIC MAP
VILLAGE OIL FIELD
COLUMBIA COUNTY, ARK.

	DATE	SHEET